NAVAL RESEARCH LABORATORY

WELCOME

Ours is a rich and productive 76-year heritage. We opened our doors to NRL in 1923, after the famous inventor Thomas Edison recommended that a “modern research facility for the Navy” be established. In 1963, NRL was first called the Navy’s “Corporate Research and Development Laboratory.” Today we continue to perform research, extending scientific and technical knowledge necessary to support a modern Navy and leading to future naval materials, components, and systems. Since its establishment, NRL has been involved in nearly every area of science and technology needed to help the Navy attain the advantage over a potential adversary.

First and foremost, we are people, about 3000, including over 800 Ph.D.s, a Nobel Laureate, and many aspirants. These people are a national trust in the truest sense.

Our scientists, engineers, and support personnel work in a campus-like atmosphere that encourages interdisciplinary projects and studies. We pride ourselves on our corporate approach to meeting Navy challenges. We strive to reward in many ways in addition to salary. Synergism abounds as one of our major strengths. While publications, patents, and licenses are important to recognize the accomplishments of our work, we aggressively seek to transfer technologies to Fleet systems.

The Laboratory is as vital and innovative today as ever. For people who place a high value on scientific and technical contributions and who put a premium on technical excellence, this is a superb place to work. Our goal is to continue to create a nurturing climate for inventiveness and productivity that supports the needs of the Navy and our nation.

CAPT Douglas H. Rau, USN
Commanding Officer

The Naval Research Laboratory's mission is to conduct a broadly based multidisciplinary program of scientific research and advanced technological development directed toward maritime applications of new and improved materials, techniques, and equipment; systems; ocean, atmospheric, and space sciences, and related technologies. This includes

- providing primary in-house research for the physical, engineering, space, and environmental sciences
- providing broadly based exploratory and advanced development programs in response to identified and anticipated Navy and Marine Corps needs
- providing broad multidisciplinary support to the Naval Warfare Centers
- providing space and space systems technology development and support, and
- assuming responsibility as the Navy's Corporate Laboratory.

MISSION

The Naval Research Laboratory opened its doors in 1923, seven years after it was first proposed in discussions between Secretary of the Navy Josephus Daniels and inventor Thomas A. Edison. The new laboratory boasted two divisions, Radio and Sound. Research divisions in Heat and Light (later Optics), Physical Metallurgy, Chemistry, and Mechanics and Electricity soon followed. Early research achievements included the discovery and explanation of radio skip distance; the development of the fathometer and early sonar; and the development of the first operational American radar, in time for use in World War II.

Thomas Edison, the great American inventor, played a major role in the establishment of the Naval Research Laboratory. For this, he has been given a place of honor at the main entrance to the Laboratory's Washington, DC site.

The postwar era was a time of great expansion for NRL. The Laboratory continued and added to its prewar research program in radio, radar, underwater sound, chemistry, metallurgy, and optics. However, it also added new research areas in nuclear science and cosmic rays; in upper atmosphere research, using V-2 and successor rockets; in radio astronomy; in electron and X-ray diffraction analysis of molecular structures; and in enhanced programs in antisubmarine warfare, electronic countermeasures, surface chemistry, solar physics, and more.

The Laboratory's Vanguard rocket project was possibly its most famous postwar R&D program. Laboratory scientists have designed, built, and launched more than 80 satellites since the late 1950s.

In the oceans, NRL's Ocean Engineering Branch, working with the Navy's Deep Submergence Project Office, acquired a worldwide reputation for searching the ocean's abyssal depths.

NRL's Laboratory for the Structure of Matter has become internationally famous for its pioneering work in using electron and X-ray diffraction methods for understanding the structure of complicated organic molecules. The Laboratory's Dr. Jerome Karle received the 1985 Nobel Prize in Chemistry for his work in this regard.

The Laboratory's current research program spans the scientific spectrum, including studies in topics as diverse as monitoring the solar corona and its impact on the Earth's atmosphere, biomolecular engineering, artificial intelligence, remote sensing, the oceanic climate, virtual reality, and superconductivity. Indeed, now over 75 years old, NRL continues to shine as the Navy's corporate laboratory and as one of the Federal Government's leading centers for innovative research in the national interest.

Dr. A. Hoyt Taylor operating a high-frequency (HF) receiver to acquire propagation data in 1923. NRL's advances in HF communication helped the Navy, the military, and the nation immensely, particularly during WWII.

NRL's top management and research library are located in Building 43. The 50-ft dish, mounted atop this building, was originally constructed in 1951 and was modified in 1958. Scientists called it the first "accurately figured" radio telescope in the world. It was used to search for particular regions of the galaxy and to pinpoint celestial objects in the heavens. The dish was later used to bounce radar signals off the moon. By 1960, other larger dishes, superior in their measurements and accuracy, made the 50-ft dish obsolete. It has become the unofficial symbol of the Naval Research Laboratory.

HISTORY

FACILITIES

In support of its diverse programs, NRL has an impressive array of modern tools for research, many of which are unique. A sampling is listed below.

- 3-MeV tandem Van de Graaff accelerator and mass spectrometer
- PHAROS III three-beam neodymium-glass laser and target facility
- Oriented Scintillation Spectrometer Experiment (OSSE) facility–Gamma Ray Observatory
- Computational Meta Facility (CMF) consisting of scalable, massively parallel-shared memory architectures accessible as remote assess:
  - Silicon Graphics Origin 2000
  - Hewlett Packard Exemplar
  - Sun Microsystems HPC Wildfire
- ATDnet Washington area POP . . . high performance, multigigabit optical DWDM streams
- Human-Computer-Interaction Laboratory
- Radar Cross Section Prediction facility
- Artificial Intelligence Center
- Central Target Simulation facility
- Versatile facilities for high magnetic field and cryogenics research
- Diffractometers
- Variety of GaAs and solid state lasers, including devices of very high power and brightness
- Nanoelectronics processing facility
- Converted 350-ft LSD ship for R&D on fire suppression and personnel protection
- Nike krypton-fluoride 5 kilojoule laser
- Spacecraft assembly, checkout, and vibration/shock/acoustic/vacuum test facility
- Radio frequency anechoic chambers
- Infrared “anechoic” chamber
- Acoustic holography pool facility
- Mode stirred chamber for creating intense electromagnetic testing environments
- Virtual reality grotto workbenches and interaction laboratory
- Advanced distributed simulation center with HPC and ATM network
- Table-top-terrawatt (T^3) laser
- Large-volume space chamber
- Laboratory for advanced material synthesis
- EPI center

NRL–Stennis Space Center (Bay St. Louis, Mississippi) and NRL–Monterey (California) perform R&D in marine geology and geophysics, oceanography, and atmospheric sciences. Other NRL locations include the Chesapeake Bay Detachment in Chesapeake Beach, Maryland; two smaller Maryland sites, Pomonkey and Tilghman Island; and the Marine Corrosion Facility in Key West, Florida.

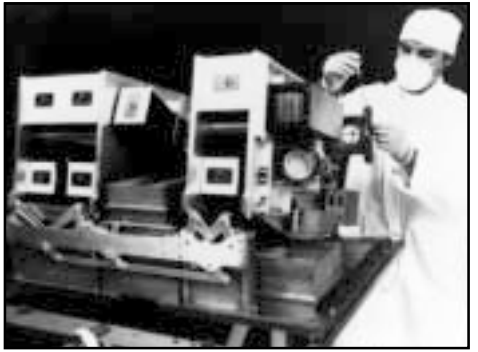
Mobile research platforms contribute greatly to NRL’s research. These include six uniquely configured P-3 Orion turboprop aircraft at the Flight Support Detachment located at the Patuxent River Naval Air Station in Lexington Park, Maryland; and one ship, the ex-USS *Shadwell* (LSD-15), berthed in Mobile Bay, Alabama.

The Naval Research Laboratory is a field command under the Chief of Naval Research, who reports to the Secretary of the Navy via the Assistant Secretary of the Navy for Research, Development and Acquisition.

Heading the Laboratory with joint responsibilities are CAPT Douglas H. Rau, USN, Commanding Officer, and Dr. Timothy Coffey, Director of Research. Line authority passes from the Commanding Officer and the Director of Research to three Associate Directors of Research, the Director of the Naval Center for Space Technology, and the Associate Director for Business Operations. Research is performed in the following organizational units:

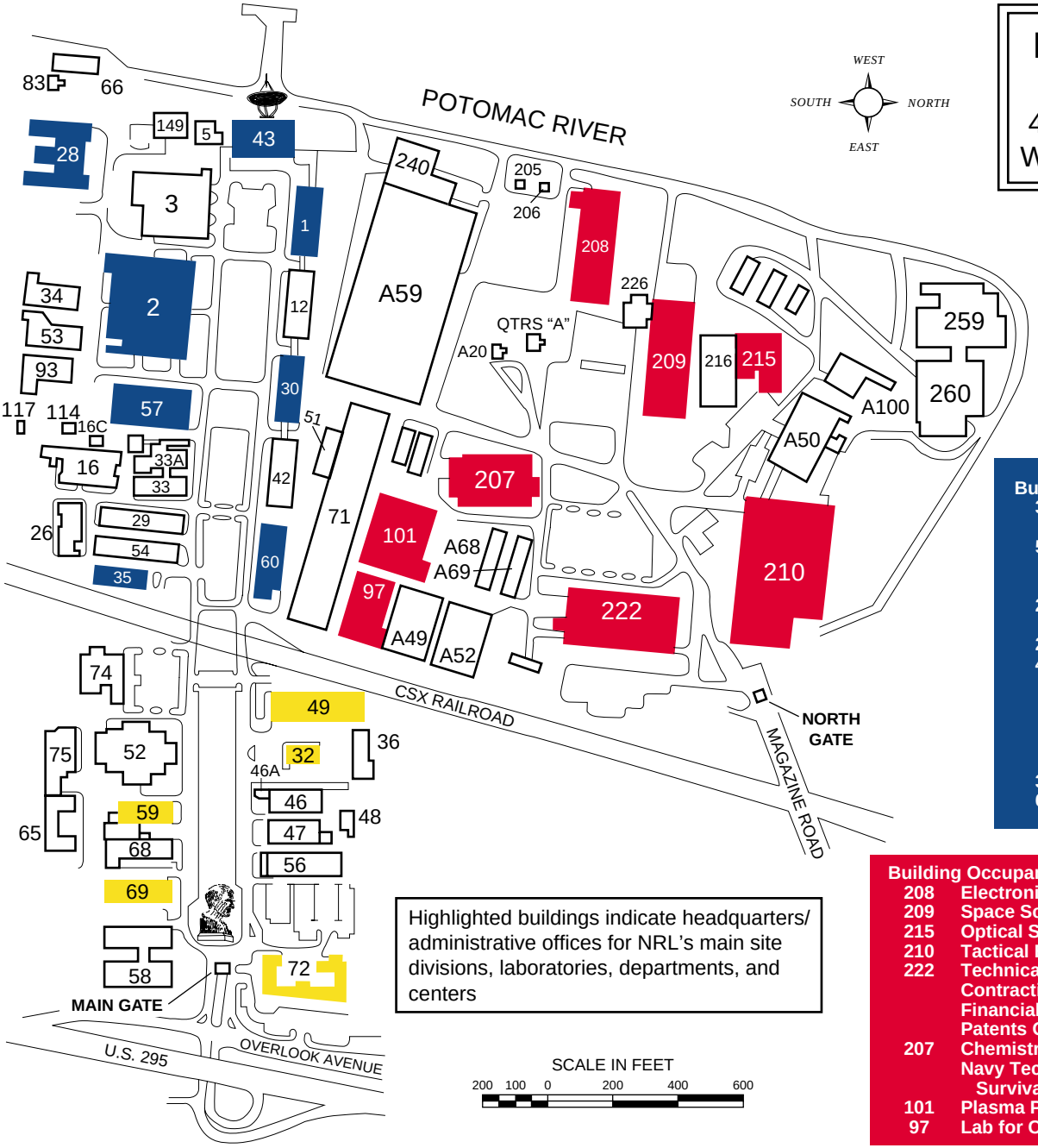
- Systems Directorate
- Materials Science and Component Technology Directorate
- Ocean and Atmospheric Science and Technology Directorate
- Naval Center for Space Technology.

NRL operates as a Navy Working Capital Funded activity. As an NWCF activity, all costs, including overhead, must be charged to various research projects. Funding in FY99 came from the Chief of Naval Research, the Naval Systems Commands, and other Navy sources; government agencies, such as the U.S. Air Force, Defense Advanced Research Projects Agency, the Department of Energy, and the National Aeronautics and Space Administration; and several nongovernment activities.



Investigating radiation detectors in a specially instrumented cryostat

ORGANIZATION AND ADMINISTRATION



NAVAL RESEARCH LABORATORY

4555 Overlook Avenue, SW
Washington, DC 20375-5320

Building Occupants

69	Naval Center for Space Technology
59	Spacecraft Eng Dept
	Space Sys Dev Dept
49/32	Supply Division
72	Incoming Visitor Section
	Guard Force
	Human Resources Office

Building Occupants

35	Laboratory for Structure of Matter
1	Information Technology Division
57	R&D Services Division
2	Acoustics Division
	Remote Sensing Division
28	Cafeteria
28	Materials Sci and Tech Division
43	Executive Directorate
	Command Support Division
	Management and Admin
	Head of Security
	Counsel/Legal
	Library
30	Center for Bio/Molecular Sci & Eng
60	Radar Division

Building Occupants

208	Electronics Science and Technology Division
209	Space Science Division
215	Optical Sciences Division
210	Tactical Electronic Warfare Division
222	Technical Information Division
	Contracting Division
	Financial Management Division
	Patents Office
207	Chemistry Division
	Navy Technology Center for Safety & Survivability
101	Plasma Physics Division
97	Lab for Computational Physics & Fluid Dynamics

Highlighted buildings indicate headquarters/ administrative offices for NRL's main site divisions, laboratories, departments, and centers

MAP

The following areas represent broad fields of NRL research. Under each, more specific topics that are being investigated for the benefit of the Navy and other sponsoring organizations are listed. Some details of this work are given in the *NRL Review*, published annually. More specific details are published in reports on individual projects provided to sponsors and/or presented as papers for professional societies or their journals.

Computer Science and Artificial Intelligence

- Advanced distributed simulations for design and warfighting
- Methods of specifying, developing, documenting, and maintaining software
- Expert systems for resource allocation, signal identification, operational planning, target classification, and robotics
- Machine learning
- Information security
- Virtual reality and interactive visual system
- Distributed interactive simulations

Device Technology

- Integrated optics
- IR sensors
- Electric field coupling
- Radiation-hardened electronics
- Nanoelectronics
- Microwave and millimeter wave technology
- Hydrogen masers for GPS
- Aperture syntheses
- Vacuum electronics
- Parallel scientific libraries, algorithms for massively parallel, shared memory systems
- Digital progressive HDTV for scientific visualization
- High performance, all-optical networking

Directed Energy Technology

- Laser propagation
- High-power microwave sources
- Pulsed power
- High energy and chemical lasers
- Pulse detonation engines
- Ram accelerators

Electronic Warfare

- Repeaters/jammers, EO/IR active countermeasures and decoys
- EW/C^{3}CM systems and technology
- Intercept receivers, signal processing, and identification systems
- Expendable autonomous vehicles
- Platform signature measurement and management
- Threat and EW systems modeling and simulation

Enhanced Maintainability, Reliability, and Survivability Technology

- Coatings
- Lubricants and greases
- Water additives and cleaners
- Fire safety and fire suppression
- Laser hardening
- Satellite survivability
- Missile blast survivability

Environmental Effects on Naval Systems

- Meteorological effects on electro-optical system performance
- Air quality in confined spaces
- Solar and geomagnetic activity
- Ionospheric behavior
- Magnetospheric and space plasma effects
- Contaminant transport

Information Technology

- Antijam communication links
- High assurance computer systems
- Information security
- Communication and information theory
- Networking - mobile, local, metro wide area
- Telecommunications - terrestrial, littoral, space
- Switched optical networking
- Distributed applications
- Battle management information systems
- High performance computing
- Next-generation signaled optical network architecture
- Teraflop scalable shared memory
- Massively parallel computer architectures
- Distributed, secure, and mobile information infrastructures
- High-end, progressive, HDTV imagery distribution
- Satellite and space communication systems
- Voice/data compression technology
- Medium- and high-frequency propagation research
- Shipboard electromagnetic interference mitigation technology

Marine Geosciences

- Geoacoustic modeling
- Marine seismology
- Geomagnetic modeling
- Geotechnology/sediment dynamics
- Mapping, charting, and geodesy

Materials

- Bio-corrosion
- Biomolecular engineering
- Theory of materials
- Mobility fuels/explosives/propellants
- Materials processing
- Advanced alloy systems
- Rapid solidification technology
- High-temperature materials
- Laser fabrication and processing
- Ceramics and composite materials
- Superconductivity
- Thin films and coatings
- Structural characterization of materials

Meteorology

- Air/sea interaction effects on operations
- Data assimilation techniques
- Global/regional forecasting
- Tactical database development
- Meteorological tactical decision aids

Oceanography

- Open-ocean, littoral, and nearshore oceanographic forecasting
- Shallow water tactical oceanography
- In situ oceanographic sensors and data fusion
- Bio-optical and fine-scale physical processes
- Waves, tides, and surf prediction

Space Systems and Technology

- Advanced space systems
- Space sensing applications
- Remote sensing of the Earth from space
- Satellite communications
- Spacecraft design, engineering, and integration
- Satellite ground station design
- Navigation technology
- Spacecraft power system technology

Surveillance and Sensor Technology

- Imaging radars
- Target classification/identification
- Underwater acoustic propagation, reverberation, and noise
- Electromagnetic sensors–gamma ray to RF wavelengths
- SQUID for magnetic field detection
- Low observables technology

Undersea Technology

- Anechoic coatings
- Fiber-optic acoustic sensors
- Shallow water environmental acoustics and sensor systems
- Target reflection, diffraction, and scattering
- Unmanned undersea vehicle dynamics
- Weapons launch

CURRENT RESEARCH

NRL PEOPLE AND PLACES

NRL today employs approximately 3000 personnel—50 military officers, 127 enlisted men and women, and 2826 civilians. In the research staff, there are about 840 doctorate degrees, 396 masters degrees, and 570 bachelor degrees. The support staff assists the research staff by providing administrative help, computer-aided designing, machining, fabrication, technical information services, personnel development, information retrieval, computer support, and contracting and supply management services.

Mosaic view of the near side of the moon lit by earthshine from images transmitted by the Deep Space Science Experiment, called *Clementine.* Designed, built, and operated by NRL, *Clementine* ended the first complete moon mapping in May 1994.

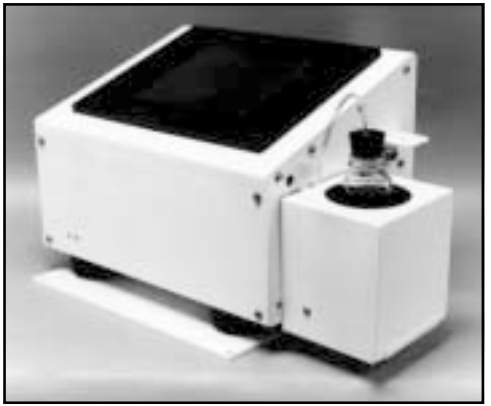
SCIENTISTS/ENGINEERS:	**1654**
Physicists	490
Chemists	119
General Physical Scientists	48
Mathematicians	37
Astronomers	50
Metallurgists	16
Computer Scientists	106
Electronics Engineers	424
Mechanical Engineers	64
Aerospace Engineers	61
Oceanographers	57
Meteorologists	45
Other	137

Evaluating materials at high temperatures under fatigue and creep conditions

Many of NRL's research efforts have commercial applications in addition to the defense-oriented objectives for which they were originally developed. NRL developments in areas such as radar, radio, satellite navigation, fiber optics, chemical and biological sensors, and a wide variety of materials and coatings have made significant contributions to the safety and welfare of the civilian community.

The transitioning of NRL's dual use technologies to the private sector is facilitated by NRL's Technology Transfer Office. This office implements the Technology Transfer Act by which Congress authorized Federal Laboratories such as NRL to participate in Cooperative Research and Development Agreements (CRADAs) and patent licensing agreements. In the past 10 years, NRL has entered into more than 200 CRADAs with industry, universities, nonprofit organizations, and other government organizations. In addition, NRL has executed over 40 licenses to its inventions. These licenses authorize the licensees to manufacture and sell a product based on NRL's technology in exchange for royalty payments that are shared by the Laboratory and the inventors.

NRL's Technology Transfer exhibit travels to various professional meetings and events around the country as a means to expose industry to NRL's leading edge developments and to encourage collaborations and licensing arrangements that will benefit both NRL and industry.



The LaserNet Fines on-line automated optical sensor system for detecting and classifying wear particles in engine lubricants is manufactured by Lockheed Martin under license from NRL.

TECHNOLOGY TRANSFER

THE COMMANDING OFFICER

CAPT Douglas H. Rau, USN, became the 33rd naval officer to command the Naval Research Laboratory on August 6, 1999. Before assuming command at NRL, CAPT Rau was the Executive Assistant to VADM George Nanos, Jr., USN, Commander of the Naval Sea Systems Command (NAVSEA).

CAPT Rau, born and raised in Mountainside, New Jersey, graduated from the United States Naval Academy (USNA) in 1974. He participated in the Immediate Graduate Education Program and then reported to Surface Warfare Officer School and qualified as a Surface Warfare Officer onboard the USS *Fox* (CG-33).

CAPT Rau continued his career serving in engineering, research, development, and project management related billets. In 1986, he transferred to the Engineering Duty Officer community.

His sea service assignments include the USS *Fox* (CG-33), Main Propulsion Assistant; the USS *Rathburne* (FF-1057), Chief Engineer; COMDESRON 35, Squardon Engineer; and the USS *Nimitz* (CVN-68), Chief Engineer.

CAPT Rau's shore duty assignments include the Pearl Harbor Naval Shipyard, Project Superintendent for DD963 overhauls; PERA(CV), Officer in Charge; the Puget Sound Naval Shipyard, Engineering and Planning Department Head; the CNO's Strategic Studies Group, Fellow; and the Bureau of Personnel, Engineering Duty Officer Community Manager.

In addition to his B.S. degree in Ocean Engineering from the USNA, CAPT Rau has also attended the University of Washington for Studies in Naval Architecture; the Naval Postgraduate School for an M.S. degree in Mechanical Engineering; and the University of Pittsburgh for the Management Program for Executives.

CAPT Rau's decorations include the Legion of Merit, Meritorious Service Medal with two stars, Navy Commendation with one star, Navy Achievement Medal, and various unit citations and campaign ribbons.

Dr. E.O. Hartwig obtained his B.S. degree in biological sciences from the University of Texas at El Paso in 1968, and his Ph.D. from Scripps Institution of Oceanography in 1974. Afterwards, as a researcher at the Scottish Marine Biological Association in Oban, Scotland, he established an experimental biogeochemical oceanographic marine microbiological effort.

In 1975, Dr. Hartwig came to the Chesapeake Bay Institute of Johns Hopkins University. His shallow water research concentrated on understanding the summer anoxia and dynamics of the Chesapeake Bay and its outflow region in active collaboration with many institutions and scientists.

From 1978 to 1980, Dr. Hartwig was a researcher at Marine Ecological Consultants, where he studied the "before operations" environment at a nuclear generating station. In addition, during this time, he established his own oceanographic analysis business. He came to the Lawrence Berkeley Laboratory at the University of California at Berkeley in 1980 to head up the biological component of a research team studying the concept of a proposed Ocean Thermal Energy Conversion plant.

Dr. Hartwig joined the Office of Naval Research in 1982 as a scientific officer in the Oceanic Chemistry/Biology Program and later became Program Manager of its Oceanic Biology Program. At ONR, Dr. Hartwig developed several major interdisciplinary research initiatives for the Navy.

As ONR's Director of Ocean Sciences (1987-1992), he enhanced both university interactions with Ocean Sciences and the stature of ONR Ocean Science scientific officers and program managers in the Federal Government.

Dr. Hartwig joined NRL in October 1992 as Associate Director of Research for Ocean and Atmospheric Science and Technology. In 1996 and 2001, Dr. Hartwig was presented the Presidential Rank Award of Meritorious Executive in the Senior Executive Service. In 2000, Dr. Hartwig was elected to be President of The Oceanography Society, an international scientific organization.

THE DIRECTOR OF RESEARCH (Acting)

The following three publications are available from the Technical Information Services Branch, Code 5210, (202) 404-4963.

- The *NRL Fact Book* gives more details about the Laboratory and its operations. It lists major equipment, current fields of research, field sites, and outlying facilities. It also presents information about the responsibilities, organization, key personnel, and funding of the divisions, detachments, and other major organizational units.
- The *NRL Review* presents annual highlights of the unclassified research and development programs. The book fulfills a dual purpose: it provides an exchange of information among scientists, engineers, scholars, and managers; and it is used in recruiting science and engineering professionals.
- *NRL Major Facilities* highlights major research areas to promote intercooperative use of these facilities between Laboratory scientists and other agencies.

To date, NRL has signed a significant number of CRADAs and licensed important technology to private industry. Specific information on NRL-developed technology is available from the Technology Transfer Office at (202) 767-7230.

General information about NRL may be obtained from Public Affairs, Code 1030, (202) 767-2541.

REVIEWED AND APPROVED
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CAPT Douglas H. Rau, USN
Commanding Officer

URL: http://www.nrl.navy.mil/